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Front Cover: Traps of *Genlisea hispida* growing through a plastic mesh. Photo by Rita Corino. Article on page 39.

Back Cover: *Drosera coalara* growing in yellow sand northeast of Badgingarra, Western Australia. Note the variability of style positions in the different flowers (left individual with upward-curved styles, middle with horizontal styles, right one somewhat in-between). Photo by Thilo Krueger. Article on page 6.

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

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ICPS CONFERENCE 2018 VIDEOS



Videos of the ICPS Conference 2018 which was held in Santa Rosa, California, have been posted on the ICPS YouTube channel (<https://www.youtube.com/user/icpstv>) and in the conference section of the ICPS main website (<https://www.carnivorousplants.org/about/conferences>). All of the talks at the conference were recorded although the posting of two talks has been delayed. Videos from the 2000 and 2010 conferences are also posted on those websites.

The almost 12 hours of videos of the 2018 conference, including the keynote address by Peter D’Amato and 12 presentations, are available to ICPS members in mp4 format on a USB Flash Drive at the ICPS Store at the ICPS membership website (<https://icps.clubexpress.com/>).

ICPS CONFERENCE 2020 - UPDATE



May 22–24, 2020
Himeji, Japan



The 13th ICPS conference and plant exhibition/sale will be held at Biz Space in Himeji City, Hyogo Prefecture, Japan from May 22 to May 24, 2020.

Please visit the conference web pages at the following URLs for registration.

http://jcps.life.coocan.jp/ICPS2020/ICPS2020_E.html

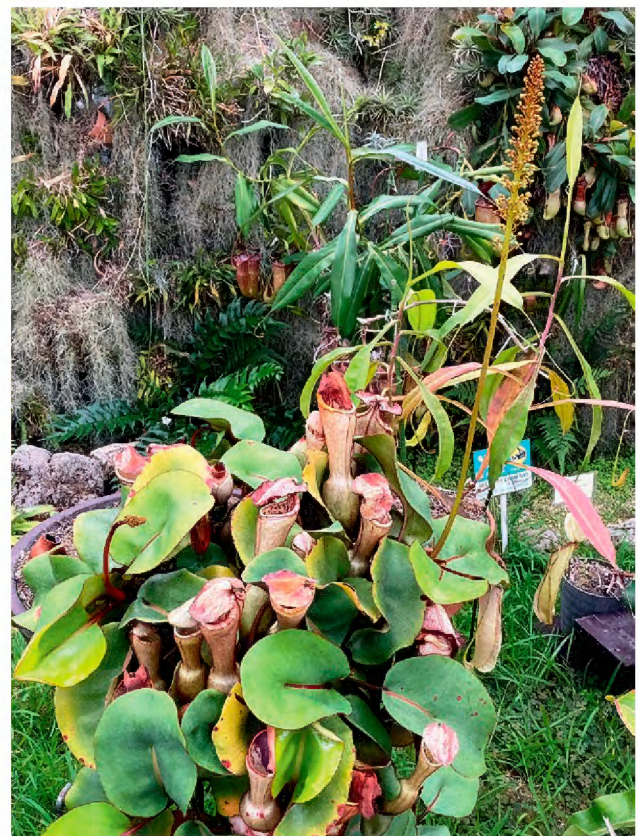
<http://jcps.life.coocan.jp/ICPS2020/index.html> <Japanese>

If you want to participate in the conference, day trip to botanical gardens, or field trips, please send an email to the conference organizer team before March 31, 2020.

By early December 2019, we had received only a small number of applications to make a presentation at the conference. Although the deadline for presentation registration was February 29, 2020, a few more presentations may be still accepted, if there is enough space in the agenda. Please apply as soon as possible. The presentations will be consecutively interpreted by professional interpreters.

After the 3-day conference, we will visit two local botanical gardens on May 25, i.e., Tegarayama Conservatory Botanical Garden and Hyogo Prefectural Flower Center. These botanical gardens have a number of carnivorous plant collections. Especially Hyogo Prefectural Flower Center is renowned as Japan's first-class CP collection. You should not miss the chance of seeing the giant *Nepenthes clipeata* and *N. pervillei*!

The 1st field trip, scheduled for May 26, will be to local habitats of sundews. We will drive to typical bogs where we can see *D. rotundifolia*, *D. tokaiensis*, and *D. lunata* (*peltata*).





The 2nd field trip, scheduled for May 27, will be to the habitat of *Pinguicula ramosa*, the rare Japan-endemic species, in Nikko City. Participants will travel from Himeji to Tokyo on May 26 evening and stay overnight.

We will walk a gentle ascent for 2 hours to the habitat. This is a very rare opportunity to see the Japan-endemic *Pinguicula*.

On the following day, it may be worthwhile to consider staying one additional night in Nikko and visit Toshogu Shrine, another World Heritage Site.



We are looking forward to seeing you in Himeji in May 2020!

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WHEN THREE BECOME TWO: *DROSER A COALARA* LINKS
DROSER A CITRINA WITH *DROSER A NIVEA*

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Keywords: taxonomy, *Drosera* sect. *Bryastrum*, pygmy *Drosera*, pollination ecology, Western Australia.

The pygmy sundews (*Drosera* section *Bryastrum*) are the second-largest group of Australian *Drosera* in terms of species number following the tuberous sundews. According to the latest revisions (Fleischmann *et al.* 2018; Robinson *et al.* 2018) they currently comprise 51 species in southwest Western Australia and six named natural hybrids (Lowrie 2014; Lowrie *et al.* 2017). Within the pygmy *Drosera*, a wide range of flower colors can be found, ranging from pure white, various shades of pink, metallic orange, and red to yellow colors, quite often with bi- or rarely even tricolored petals (Lowrie 1989; Robinson *et al.* 2018). The color combination of lime yellow petals with white base has thus far been considered to be unique to *D. citrina* (Lowrie & Carlquist 1992; Lowrie 2014; Lowrie *et al.* 2017).

When first discovered in flower, *Drosera citrina* was described by Lowrie (1989; initially mistaken for *D. rechingeri*, until correctly classified by Lowrie & Carlquist 1992) to be one of the most unique pygmy *Drosera* due to its striking flower color. The white-flowered *D. nivea* was denoted as its closest relative by Lowrie & Carlquist (1992), but considered to represent a variety of *D. citrina* by Schlauer (1996) – the latter classification was not adopted by most *Drosera* taxonomists (e.g., Lowrie 1998, 2014; Lowrie *et al.* 2017; Fleischmann *et al.* 2018). With the description of *D. coalara* by Lowrie (2014), another closely related taxon was added

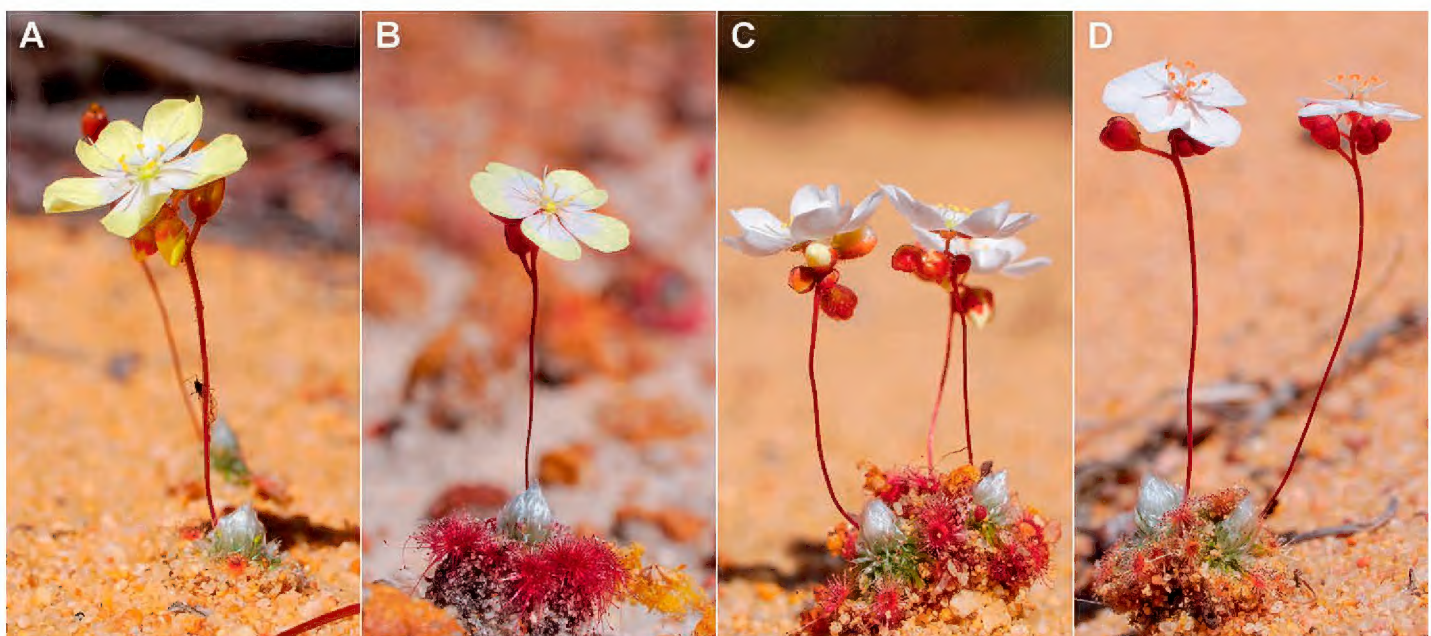


Figure 1: Comparison of *Drosera citrina* (Moora, A), *D. coalara* (from two different localities NE of Badgingarra, B, C), and *D. nivea* (Coorow, D). Photos: Thilo Krueger.



Figure 2: Sympatric occurrence of white- and yellow-flowered color morphs of *Drosera coalara*, northeast of Badgingarra, Western Australia. Photo: Thilo Krueger.

	<i>Drosera citrina</i>	<i>Drosera coalara</i>	<i>Drosera nivea</i>
White flower color			
Yellow flower color			

Figure 3: Comparison of white- and yellow-flowered color morphs of *Drosera citrina*, *D. coalara*, and *D. nivea*. *Drosera citrina*: both from Moora; *D. coalara*: both northeast of Badgingarra; *D. nivea*: top from Coorow, bottom southwest of Coorow. Photos: Thilo Krueger.

to this affinity of species from the northern sand plains of southwest Western Australia (Fig. 1). At the time of its description, *D. coalara* was considered to be entirely white-flowered, just like *D. nivea*. Expeditions and field work by the first author in Western Australia revealed not only additional localities of the white-flowered variant of *D. citrina* (one of them already known to Lowrie (1989: 154): “An all-white-flower form of this species occurs at one location near Moora.”), but also found white- and yellow-flowered *D. coalara* in mixed populations (Fig. 2), and surprisingly also yellow-flowered populations of *D. nivea*, hence all three species are now known to consist of both white- and yellow-flowered individuals (Fig. 3). Therefore, the diagnostic characters delimiting these three species were re-investigated in the light of the new populations and data discovered, and some characters such as stipule shape and flower number as described by Lowrie (2014) were examined on a wider range of specimens and populations (including the type localities for all three taxa, as well as the type specimens).

Distribution and Habitats

All three taxa are confined to the sand plains and heathlands between Coorow and Gingin in southwest Western Australia (Fig. 4). *Drosera citrina* only occurs in deep yellow sands in open *Banksia* forests (or rarely in heathland) on the Dandaragan Plateau between Moora and Gingin. It is currently known from ca. 10 populations (Fig. 4). White-flowered plants of *D. citrina* from near Moora were first reported by Lowrie (1989; erroneously as “*D. rechingeri*” at the time). *Drosera nivea* inhabits deep white to beige sands on sand-plains among low heath vegetation (Lowrie 1998, 2014), and it has been recorded from seven sites between the towns of Coorow and Watheroo (Fig. 3). In Lowrie (2014), the range of *D. nivea* was erroneously illustrated ca. 100 km to the east of its actual range. *Drosera coalara* was only known from two localities according to the original description, namely the type locality northeast of Badgingarra, and a small roadside population west of Mogumber, which is ca. 96 km distant to the south (Lowrie 2014). According to the authors of the present work, the Mogumber population reported by Lowrie likely represents white-flowered *D. citrina* due to their relatively long peduncles (curiously, the Mogumber site also has not been included in the species’ range map by Lowrie 2014). This would leave only the *locus classicus* for *D. coalara*. In September 2019, the first author of this work discovered at least seven additional populations of *D. coalara*, most of which lie within the ca. 100 km diameter circle that was drawn around the type locality of *D. coalara* to illustrate the species’ distribution in Lowrie (2014). Two of these populations were, however, found near Wannamal, more than 100 km south of the type locality. *Drosera coalara* grows in a wide range of different heathland habitats, including deep yellow, beige, and gray sands and even almost pure laterite (pers. obs; Lowrie 2014).

Drosera citrina and *D. nivea* show allopatric distribution (their ranges do not overlap, both species are separated geographically by ca. 50 km between the closest localities, Fig. 4), *D. coalara* is parapatric with *D. nivea* (the ranges touch in a narrow border zone but do not overlap much) and sympatric distribution with *D. citrina*. The ranges of all three species seem to represent a continuum (Fig. 4) – and it might be better to consider only two taxa, *D. citrina* in the south, *D. nivea* in the north, both mediated by transitional forms in-between, which have been described as *D. coalara*. In the range border zones, transitional forms occur (especially between *D. nivea* and *D. coalara*), but we did not observe sympatric occurrence of two or more of the above-mentioned three taxa.

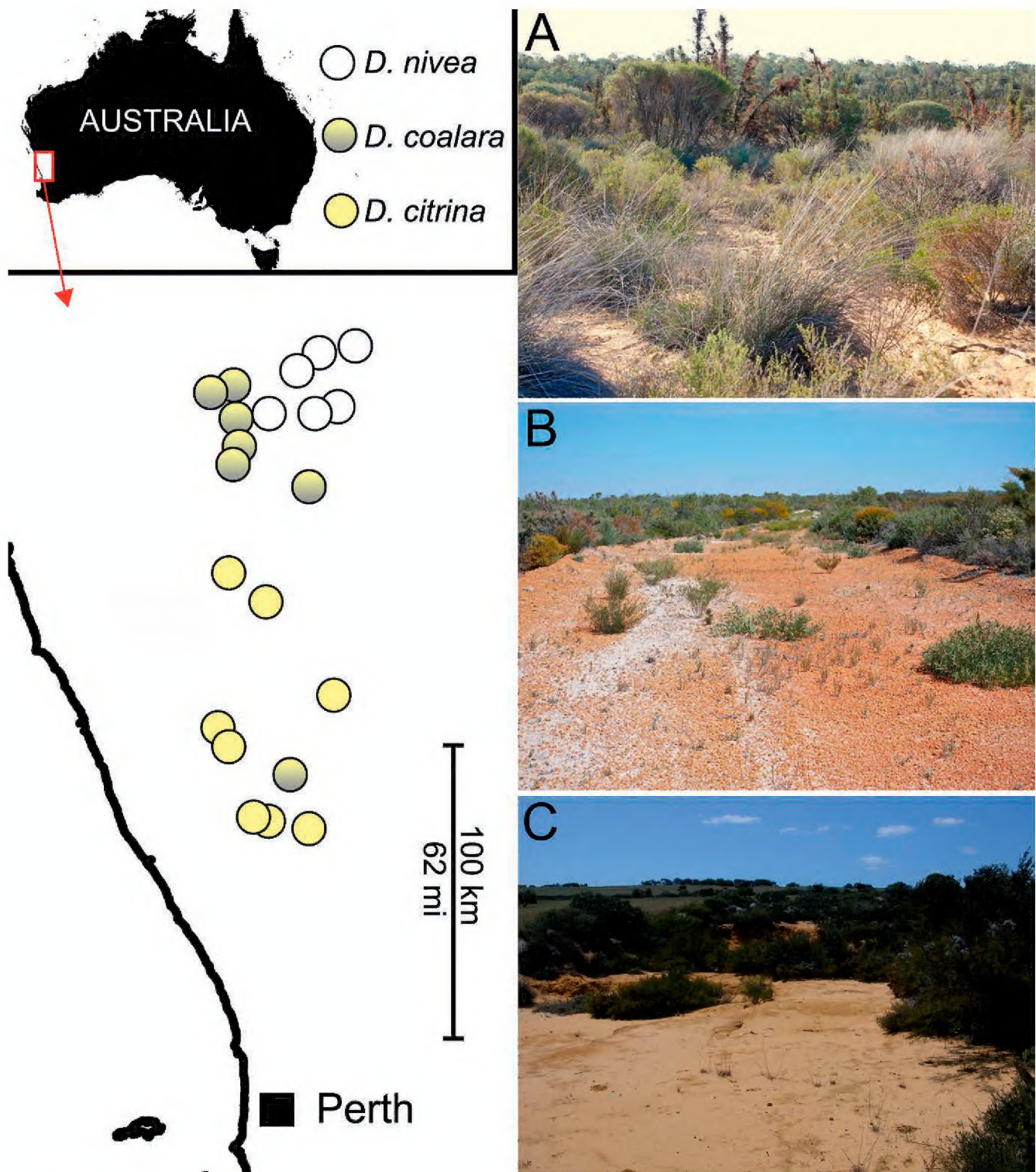


Figure 4: Distribution map based on Atlas of Living Australia (2019), Lowrie *et al.* (2017) and personal observations. All localities have been visited and confirmed by the authors of this work. Instead of three distinct species, the range can also be interpreted as a grade from *D. citrina* (predominantly yellow flowers) in the south to *D. nivea* (predominately white flowers) in the north, geographically and morphologically linked by *D. coalara* in the middle. Right: typical habitats of *D. nivea* (A, near Coorow), *D. coalara* (B, near Badgingarra) and *D. citrina* (C, near Regans Ford). Photos: A, B by Thilo Krueger, C and Map by A. Fleischmann.

Discussion

Pollinators apparently do not distinguish between yellow- and white-flower color morphs – so why should botanists do so and call them different species?

Both yellow- and white-flowered individuals of *D. coalara* were found growing intermixed within the same population at all eight sites (including at the type locality) with varying percent-



Figure 5: This white-flowered morph of *D. coalara* (right) was visited – and very likely also pollinated – by the same individual of the bee-fly *Choristus* (Diptera: Bombyliidae; genus identified by X. Li) just four seconds after floral visit at a yellow morph (left). Note the *Drosera* pollen sticking to its left foreleg (arrow) from the first flower visit, enabling potential cross-pollination. Photos: Thilo Krueger.

age distributions of flower colors. Since all plants were flowering at the same time, and without any morphological difference of the plants apart from flower color (T. Krueger, pers. obs. 2019; Figs. 2, 5), these can be considered color morphs of one and the same species (not even worth being recognized taxonomically on forma rank). A pollinating bee-fly of the genus *Choristus* (family Bombyliidae; genus identified by X. Li) was observed by the first author to freely choose between the yellow and white flowers, without avoiding any of them, enabling cross-pollination (Fig. 5). Therefore, the mixed petal colors of *D. coalara* certainly belong to the same population's gene pool. Populations containing different color morphs are not unusual among flowering plants in general, and in *Drosera* in particular (e.g., most of the woolly sundews of *D. sect. Lasiocephala* occur in white- and pink-petalled individuals within the same population; pers. obs.). Intraspecific flower color variation (as observed by the human eye) was often found to be effectively invisible to specific pollinators in other plants, hence will persist in the population by genetic drift/neutral evolution (Paine *et al.* 2019).

Different small beetles have been observed by the authors as floral visitors of *D. citrina* and *D. nivea*, the latter species additionally shows signs of myophily (pers. obs.). Populations of *D. citrina* are predominately yellow-flowered, with occasional occurrence of white-flowered individuals among the populations. We did not find entirely white-flowered populations of *D. citrina*. In fact,

Table 1. Taxonomic comparison between *Drosera citrina*, *D. coalara*, and *D. nivea*. Data based on Lowrie & Carlquist (1992), Lowrie (1989, 1998, 2014), and own observations from the field and from cultivation. Note the wide morphological overlap of *D. coalara* with the two other species, especially with *D. citrina*.

character	<i>Drosera citrina</i>	<i>Drosera coalara</i>	<i>Drosera nivea</i>
peduncle length	1.7-4.5 cm	1.5-3.0 cm	2.5-3.5 cm
number of flowers per scape	(4)6-12(-16)	(2)3-6(-10)	(2)4-6(-10)
petal color	predominantly white with yellow margin, rarely pure white	white or white with yellow margin	white, occasionally white with pale yellow (cream) margin
ovary color	yellowish-green	yellowish-green	pale red, rarely green
pollen color	yellow	yellow	orange
habitat	yellow sand on heathland	yellow, beige or gray sand, rarely laterite	deep beige sands on sand plains and heathland

***Drosera citrina* Lowrie & Carlquist**, Phytologia 73(2): 99 (1992)
 =*Drosera rechingeri* auct. non A.Strid, Carniv. Pl. Austral. 2: 154-157, xviii, xxxiv (1989).
 =*Drosera chrysochila* Schlauer, Palmengarten 1992(3): 190 (1992).
 =*Drosera coalara* Lowrie & Conran, Carniv. Pl. Austral. Magnum Opus 3: 1269 (2014), **syn. nov.**
***Drosera nivea* Lowrie & Carlquist**, Phytologia 73(2): 104 (1992)
 =*Drosera citrina* var. *nivea* (Lowrie & Carlquist) Schlauer, Carniv. Pl. Newslett. 25(3): 72 (1996).

the white-flowered forms were extremely rare within the populations. The first author observed less than 10 white-flowered *D. citrina* amongst tens of thousands of yellow-flowered plants at a population near Moora. While most populations of *D. nivea* are predominantly white-flowered, intermixed and even purely yellow-flowered populations have been found by the first author.

Three species, two, or a single variable one?

Given the new data on variation and range overlap of the three taxa, the question arises how to best classify them – especially in the case of *D. citrina* and *D. nivea*. Intraspecific classification might be more appropriate in this case than two separate species. Schlauer (1996) suggested to distinguish the two taxa on variety rank – however, in his concept that would suggest sympatry (which has never been observed so far), and so the rank of subspecies (i.e., allopatric distribution) might be more appropriate. However, in the present work, we distinguish both taxa on species rank, with *D. coalara* treated as conspecific with *D. citrina*. We do so because typical plants of *D. citrina* and *D. nivea* can still be reliably separated based on habitat, distribution range, and few morphological characters (see also Table 1).

Lowrie and Conran (1992) and Lowrie (1998, 2014) consider the pedicel length to be a key character to delineate *D. citrina* from *D. nivea* (pedicel length 2.5-3.0 mm in *D. citrina* vs. 1.5-2.0 mm in *D. nivea*). Although *D. nivea* at its type population near Coorow has relatively longer pedicels than *D. citrina* from the southern part of its range, in a greater picture, the pedicel length of all known populations (including *D. coalara*: pedicel length 1.0-1.5 mm sensu Lowrie 2014) shows



Figure 6: The peduncle and also pedicel length of *D. coalara* is extremely variable, even within the same population. The left and the right individuals were found less than 10 m apart, the one with shorter scapes at an area much more exposed to full sun. Photos: Thilo Krueger.

much variation and size overlap (Figs. 1, 6). Therefore, we do not consider this character to be of taxonomic value to tell apart these species.

Drosera nivea often has notably longer peduncles than *D. coalara* and *D. citrina* (pers. obs.), however especially the latter has more flowers (up to 16, compared to 4-6 (rarely up to 10) flowers in *D. nivea*; Lowrie 2014; however, the total number of flowers per scape in *D. citrina* has some geographic bias, with populations in the south bearing more flowers per scape, often 10-14, compared to mostly 6-8 flowers in northern populations), so that the total height/length of the flower scapes is similar in both species. However, both species frequently develop a second inflorescence, which is shorter in height and fewer-flowered – hence distinguishing features given here in Table 1 are based on the season's primary inflorescence. *Drosera coalara* generally produces the shortest peduncles of the three species (Fig. 1), although peduncle length is quite variable in that taxon (even within the same population). Some individuals were observed to produce relatively long scapes, and hence closely resemble *D. nivea* except for ovary and pollen color (compare Fig. 1D with Fig. 6 left), while less than 10 m away plants with much shorter peduncles occurred (Fig. 6). Notably, individuals growing in more exposed parts of the habitat generally produced shorter and more reddish peduncles.

Lowrie (2014) describes upward-curved styles as a diagnostic feature of *D. coalara* (in contrast to the horizontally spread styles of *D. citrina* and *D. nivea*). However, horizontally spread styles

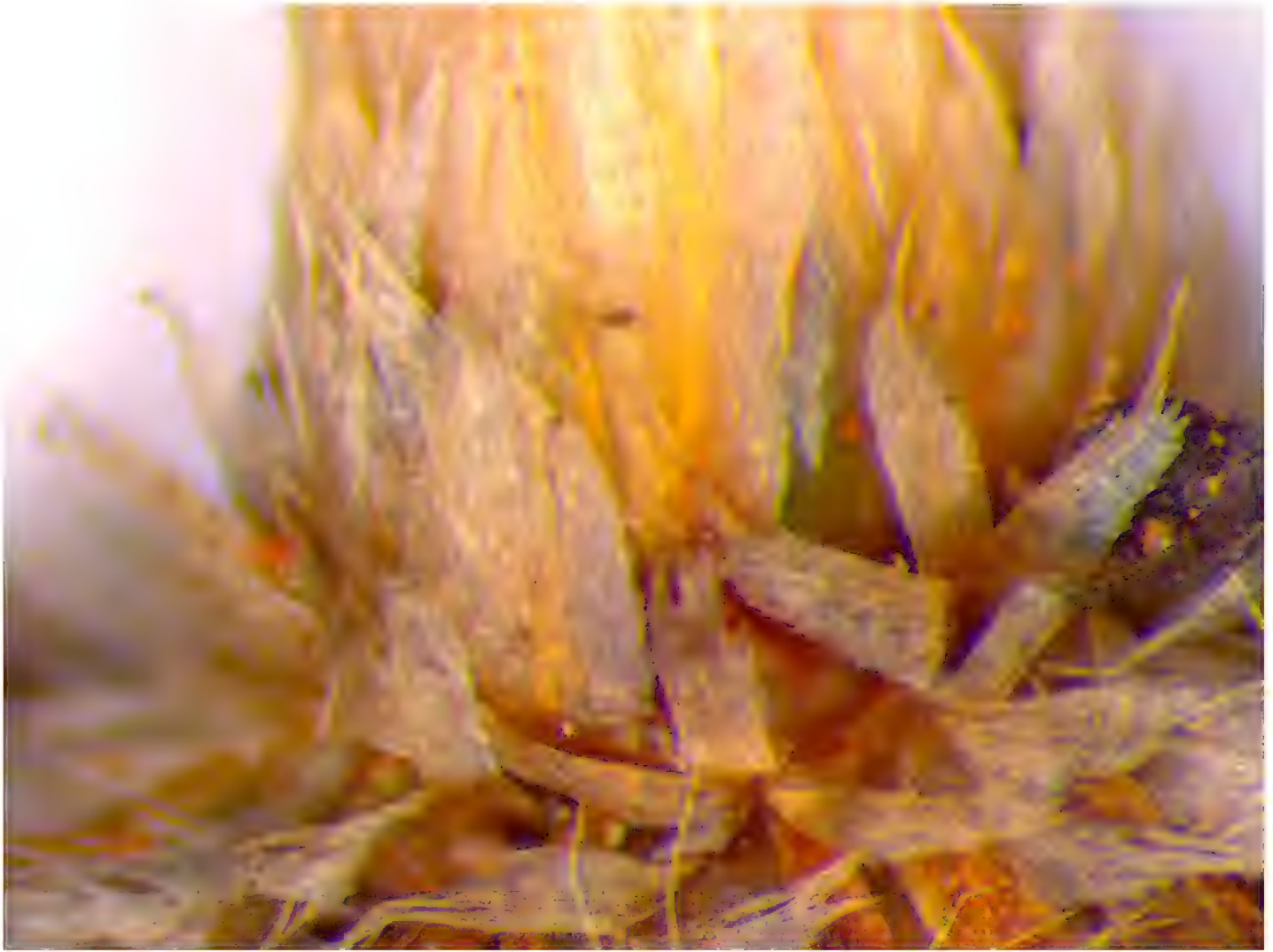


Figure 7: Close-up of the stipules from the type material of *D. coalara* (MEL2425943; isotype). Photo: Alastair Robinson.

(identical to those of the other two species) were observed in all populations of *D. coalara* studied (including at the *locus classicus*), and such are also pictured on the majority of habitat photographs of the species in Lowrie (2014: 373 figs. A, C & F). Only a single photograph in Lowrie (2014: 373 fig. D) depicts upward-curved styles. The first author occasionally observed upward-curved styles in a few individuals in any population of *D. coalara*, *D. citrina*, or *D. nivea* visited, often in freshly opened or senescent flowers. Hence this might not represent a stable feature, but rather a transitional stage during anthesis (see Back Cover).

The shape of the dome-shaped stipule bud (especially during dormancy) has been used by Lowrie (2014) as a further character to delimitate *D. citrina* from *D. nivea* (and *D. coalara*). Indeed, *D. citrina* usually has a much broader, smoother stipule bud compared to the more narrow, ovoid and bristly appearance of the stipule buds of *D. coalara* and *D. nivea*. However, this feature was not observed to be consistent as within each population of *D. citrina* some individuals produced the same type of stipule bud as the other two taxa. Likewise, some plants of *D. coalara* (even at its type locality) possessed a broad and smooth stipule bud extremely similar to *D. citrina*.

Lowrie (2014) highlighted the stipules of *D. coalara* to be notably different from those of *D. citrina* and *D. nivea*, with the former having stipules with very short apical laciniae, while those of the other two species are long-laciniate. However, the present authors have found stipules of *D. coalara*, including those from the type material (Fig. 7), not to match those illustrated in Lowrie (2014: 370-373). Instead they are identical to those of *D. citrina* and *D. nivea* – these three taxa cannot be distinguished based on stipule characters (Fig. 8), in contrast to the diagnosis given by



Lowrie (2014). Additionally, the shape and size of the stipules in most pygmy *Drosera* varies with the seasonal growth cycle, with stipules of dormant stipule buds or during gemmae production often being notably different from those produced during active growth (pers. obs.) – hence it is critical to document the stipules of the entire growth cycle, and compare among different populations of the same species, to get a clear picture of the individual ontogenetic and the intraspecific variation. Finally, the characters of petiole shape in section and lamina outline as mentioned by Lowrie (2014: petiole in section lenticulate and lamina more or less orbicular in *D. coalara*; petiole in section oblong with longitudinal ridges and lamina orbicular or elliptic in *D. citrina*; petiole in section depressed obovoid and lamina elliptic in *D. nivea*) were found to be variable within a population and even a given individual depending on the respective leaves and time observed (pers. obs.), and generally identical in all three taxa at the same developmental stage of the seasonal growth cycle. This leaves no reliable vegetative character to tell apart *D. citrina* from *D. nivea* in sterile specimens, both can only be distinguished with certainty based on flower characters (see above and Table 1).

As all major morphological characters of *D. coalara* fall within the observed variation of *D. citrina* (see Table 1), we consider both taxa to be conspecific, with *D. coalara* representing a heterotypic synonym of *D. citrina*. There is also significant morphological overlap with *D. nivea*, but that species can be distinguished from *D. citrina* (including *D. coalara* and regardless of color morph) by its orange pollen (vs. yellow pollen in *D. citrina/D. coalara*), usually longer peduncles and a mostly pale red ovary (vs. ovary always greenish-yellow; see Table 1 and Figs. 1, 3). In cultivation, if kept under identical growing conditions, *D. nivea* (plants from near Coorow are most frequently grown) also flowers notably earlier than *D. citrina*, usually 1-2 months ahead, leaving little or no overlap in flowering time, with *D. citrina* usually opening its first flowers when all those on the scapes of *D. nivea* are already spent (pers. obs.). However, their phenology in the wild does not differ as much as in cultivation, and all three taxa have been observed in full bloom in Western Australia by the first author in mid-September 2019. *Drosera nivea* from near the type locality and *D. citrina* from Moora both had opened their third or fourth (on average) sequential flower on the scape at the time (T. Krueger, pers. obs.). However, at least the more southern populations of *D. citrina* (e.g. those near Gingin) appear to exhibit a more extended anthesis time, flowering at least until mid-October and also bear considerably more flowers per inflorescence (pers. obs.).

Figure 8: (facing page): Comparative close-up images of stipules from different populations of *D. citrina* (A-F), *D. nivea* (G-L), and *D. coalara* (M-X). Stipule shape is very variable in all three taxa and it is thus impossible to delineate species based on this feature. A: *D. citrina*, Gingin, October 2014; B: *D. citrina*, Gingin, October 2014; C: *D. citrina*, Mogumber, September 2019; D: *D. citrina*, Moora, June 2019; E: *D. citrina*, Moora, September 2019; F: *D. citrina*, Moora, September 2019; G: *D. nivea*, Coorow 1, October 2014; H: *D. nivea*, Coorow 1, October 2014; I: *D. nivea*, Coorow 2, September 2019; J: *D. nivea*, Coorow 2, September 2019; K: *D. nivea*, SW of Coorow, September 2019; L: *D. nivea*, SW of Coorow, September 2019; M: *D. coalara*, locus classicus, June 2019; N: *D. coalara*, locus classicus, June 2019; O: *D. coalara*, locus classicus, September 2019; P: *D. coalara*, locus classicus, September 2019; Q: *D. coalara*, Locality 1, September 2019; R: *D. coalara*, Locality 1, September 2019; S: *D. coalara*, Locality 1, September 2019; T: *D. coalara*, Locality 1, September 2019; U: *D. coalara*, Locality 2, September 2019; V: *D. coalara*, Locality 3, September 2019; W: *D. coalara*, Locality 4, September 2019; X: *D. coalara*, Locality 5, September 2019. All photos by Thilo Krueger.

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IN PURSUIT OF MEXICAN *PINGUICULA*: A JOURNEY TO NORTHWESTERN OAXACA

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After much planning and aligning our schedules, we finally defined the dates to visit populations of various *Pinguicula* species in northwestern Oaxaca, Mexico. It is essential to highlight that the state of Oaxaca has the greatest biodiversity in Mexico, as regard to vascular plants, it has 10,299 species, of which 4,071 are endemic to the state (Villaseñor 2016). It is also the state where it is possible to find most *Pinguicula* species (Table 1). Fifteen species have been reported, including the recently described *P. pygmaea* (Rivadavia *et al.* 2017). Also, some of these species are controversial and under taxonomic discussion, i.e., *P. rectifolia* and *P. medusina*, whereas others have not been seen since they were first collected (*P. greenwoodii* and *P. utricularioides*).

Our meeting spot was in the city of Puebla on 15 July 2019. From there, we departed in a pickup truck toward the first location of our journey along the Tehuacán-Oaxaca highway. After a couple of hours of travel, filled with enjoyable and fun conversation, we arrived at the location. We parked the vehicle in a safe place and prepared to climb the mountain in search of a population of *Pinguicula mirandae*. Despite having visited this site previously, Martín got confused and guided the group up a slope that he thought was the right way. The ascent was complicated because of the density of plants, many of which bear thorns or spines (*Haematoxylum brasiletto*, *Havardia acatlensis*, *Caesalpinia melanadenia*, *Leucaena lanceolata*, *Mimosa lacerata*, *M. polyantha*, *M. luisana*, *M. mollis*, *M. lactiflua*, *M. aculeaticarpa*, *M. benthamii*, *Hechtia* sp., and others). Complicating our climb was the steep, rugged terrain composed of lots of loose stones (lithic leptosol, Arriaga *et al.* 2000). Our goal was to reach a vertical wall cut in the mountain side above the highway and from there walk a few meters to find the population of *P. mirandae*. Although Martín realized that it was not the right way to the population that he had previously visited, we decided to continue in order to find out if there was also *P. mirandae* on the cliffs above. Martín was at the head of the group, followed a few meters behind by Mané and Julián. As enthusiastic botanists, they were amazed by the plants found along the way, such as *Tillandsia grandis*, *Sedum alantoides*, *S. compactum*, *Dasyilirion serratifolium*, *Agave petrophila*, *A. kerchovei*, *A. karwinskii*, *A. macrocantha*, and *Beaucarnea gracilis*.

The first pleasant surprise was to observe on our way a beautiful and quiet black-tailed rattlesnake (*Crotalus molossus*). We tried to make no sound, but in the time it took us to take the cameras out of the backpack and get closer to it, the rattlesnake felt our presence and began to slither away and hide in a hole under a large rock. Since we moved slowly and kept a reasonable and safe distance, it didn't feel threatened and allowed us to take some photos (Fig. 1). It never rang its rattle or tried to intimidate us with attack-defense movements, and after a brief photoshoot, we left it alone and continued on our way. When we reached the northeast-facing wall, we could observe *Pinguicula* plants on the inaccessible upper rock face about 7-10 meters from our position (Fig. 2), sadly though, we did not observe any at our level, and thus we decided to head back. The descent of the mountain took us about one hour, and we drank water to keep hydrated and then began our ascent to

Table 1. <i>Pinguicula</i> species naturally occurring in Oaxaca, Mexico.		
Species	Habitat	Distribution in Mexico
<i>P. konzattii</i> Zamudio & van Marm	Montane cloud forest	Oaxaca
<i>P. crenatiloba</i> A.DC.	Tropical Savannah climate	Chiapas, Estado de México, Guerrero, Jalisco, Michoacán, Morelos, Nayarit, Oaxaca, Sinaloa, Sonora
<i>P. gigantea</i> Luhrs	Tropical rain forest	Oaxaca
<i>P. greenwoodii</i> Cheek	Tropical Savannah	Oaxaca
<i>P. hemiepiphytica</i> Zamudio & Rzed.	Montane cloud forest	Oaxaca
<i>P. heterophylla</i> Benth.	Mainly Oak-Pine forest	Guerrero, Morelos, Oaxaca
<i>P. laeana</i> Speta & F.Fuchs	Montane cloud forest and Oak-Pine forest	Oaxaca
<i>P. lilacina</i> Schltdl. & Cham.	Oaks woods, Pine-Oaks woods or cloud forest at elevations from 700-2400 m	Chiapas, Guerrero, Jalisco, Nayarit, Nuevo León, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz
<i>P. medusina</i> Zamudio & Studnicka	Xeric shrubland, semi-arid ecosystem with gypsum soils	Oaxaca
<i>P. mirandae</i> Zamudio & A.Salinas	Tropical deciduous forest and thorny xerophytic scrub	Oaxaca
<i>P. moranensis</i> Kunth	Several ecosystems, with elevations ranging from 770-3200 m	Chiapas, Guanajuato, Guerrero, Hidalgo, México, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, Querétaro, San Luis Potosí, Tamaulipas, Veracruz
<i>P. orchidioides</i> DC.	Deciduos oak-pine forest	Guerrero, Oaxaca
<i>P. pygmaea</i> Rivadavia, E.L.Read & A.Fleischm.	Xeric shrubland, semi-arid ecosystem with gypsum soils	Oaxaca
<i>P. rectifolia</i> Speta & F.Fuchs	Tropical deciduous forest	Oaxaca
<i>P. utricularioides</i> Zamudio & Rzed.	Montane cloud forest	Oaxaca



Figure 1: A beautiful black-tailed rattlesnake (*Crotalus molossus*) guarding the habitat of *Pinguicula mirandae*.

the next wall. Again, after struggling with diverse thorny thickets and loose stones, we reached the base of the vertical wall and almost immediately observed the first plants of *P. mirandae*. We continued along the base of the wall until we reached a small precipice with a northwest orientation. There, between the cracks of the rocks, we could observe a considerable number of plants, and in some cases, there were rows of a dozen individuals (Fig. 3). We conjectured that this peculiar distribution of individuals is because in these places, the seeds can accumulate and find the right conditions of moisture, temperature, and soil to germinate and grow.

On the date of our visit (summertime in Mexico and at the beginning of the rainy season), most of the plants already formed their summer rosettes, and unfortunately, we could not find any flowers or capsules. An exceptional phenomenon present in this population was that under the same conditions of soil and light, plants with green and reddish tones grew intermingled (Fig. 3). Also, we observed plants of *P. mirandae* on the vertical wall in asso-



Figure 2: Plants of *Pinguicula mirandae* below an *Agave macrocarpa* at the upper of the wall and out of our reach.



Figure 3: Different sizes of *P. mirandae* plants in summer rosettes with green and reddish tones.

ciation with *Tillandsia grandis*, *Selaginella lepidophylla*, *Agave petrophila*, and *Hechtia* sp. The number of plants of *P. mirandae* at this site was relatively low since we could only observe them in an area of 10 square meters. We climbed a few more meters on one side of the wall, but the density of the plants decreased until we no longer could find them.

Within the different species of Mexican *Pinguicula*, it is common to encounter small populations limited to a specific area, and such populations are threatened because any alteration of the habitat or poaching could lead to their demise. By that time, it was late in the afternoon, so we returned to the pickup truck and decided to travel to the city of Tehuacán to spend the night and eat a necessary dinner, which was particularly well received because after a long day of *Pinguicula* searching, we were starving!

The next day we departed early toward the next site of the field trip, an area along Highway 15 (Huajuapán de León-San Miguel Tlacotepec), where there is a wall in the west side of the road that is used to advertise, with a big graffiti, music events (the famous Mexican band dancing). There it is pos-

sible to find a population of *P. moranensis* or perhaps *P. rectifolia*, because both species are quite similar. In fact, for some botanists the latter species is synonymous with the former (Lampard *et al.* 2016; Hernández & Zamudio 2017). We observed the plants distributed in the basal part of the wall, near the ground, but most of them were in the upper part of the wall, precisely below the vegetation comprised of *Manfreda verhoekiae*, *Quercus magnoliifolia*, *Q. castanea*, *Q. glaucoides*, *Brahea dulcis*, *Psidium guajava*, and *Conzattia multiflora* (Fig. 4a). During a previous visit to the site a few years earlier, it was possible to observe more plants across the wall, but inevitably the negative impact of constant graffiti has limited their growth to its lower and upper portions (Fig. 4b). The plants had already formed their carnivorous summer leaves and possessed many flowers with a great diversity in size, shape, and color tones (Fig. 4 c-e); also, there were a lot of capsules and seeds (Fig. 4d). It is frequent to find populations of butterworts, mainly of *P. moranensis*, on the adjacent walls of roads and highways, and they thrive pretty well in spite of the disturbances caused by traffic and the continuous maintenance, which consists mainly of cutting the grasses along its edges. Contrary to what one might expect, this species seems to be favored by these altered conditions and sometimes forms huge populations.

We followed our route and after a few kilometers arrived at “El Boquerón”, an impressive canyon carved out by a tributary of the Salado River and framed along its sides by beautiful, pristine tropical deciduous forest. This area is a flora and fauna protection area, and it has a beautiful path with wonderful panoramic views (Fig. 5a). After a few minutes of walking along the trail and enjoying the view, we observed on the vertical walls (limestone), shaded areas that presented water drainages having accumulations of calcium carbonate concretions (caliche). In this peculiar niche,



Figure 4: a) Population of *P. moranensis* or *P. rectifolia* thriving on a wall next to the highway b). The plants grow only on the base or upper part of the wall, c, d, e). There is great variation in the size, shape, and color of the flowers.

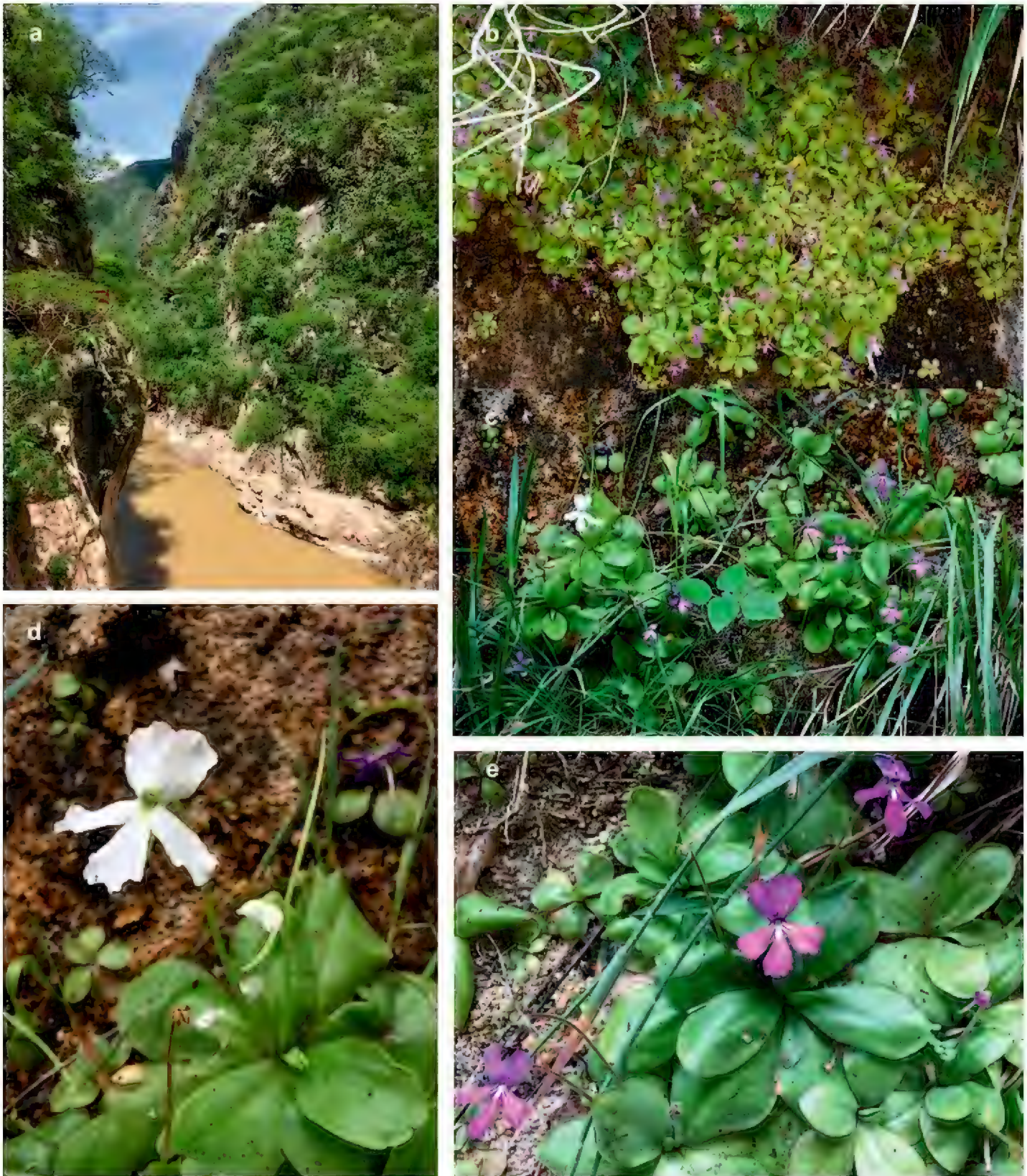


Figure 5: a) Panoramic view of flora and fauna protection area El Boquerón. b-e) The colonies of *P. rectifolia* were amazing and the plants had a great diversity of shapes and colors.

plants of *P. rectifolia* thrive. At first, these spots had only a few individuals, but some meters ahead the number of plants increased considerably (Fig. 5b). Most of them had large summer leaves and were in full bloom (Fig. 5 b-e). It was astonishing to appreciate the spectacular and synchronous pink to magenta bloom, and we even saw occasional individuals with white flowers (Fig. 5d). Most of the Mexican butterworts grow in association with other species, but in this locality, the presence of other species was low, and only a few grasses were visible with the higher clumps of *Pinguicula* and an occasional maidenhair fern (*Adiantum* sp.).

Adjacent to the path, there is an irrigation channel approximately three meters wide running next to the mountain wall. The plants are located at a height of 3 to 5 meters, making it difficult to

reach them, which is very convenient so that they are not easily collected or accidentally damaged by visitors. At the time, we visited this population, it was the beginning of the rainy season, so the level of water in the channel was low. This allowed Mané to skillfully transverse the channel and observe the plants close up (Fig. 6). It was also possible to collect some individuals for herbarium specimens to be deposited in the herbaria IBUG of the Universidad de Guadalajara and XAL of the Instituto de Ecología, A.C.

Pinguicula rectifolia thrives in this area, taking advantage of its yearlong warm weather and permanently wet walls, presumably the result of microclimatic conditions. The individuals of this population do not form winter rosettes, something unusual if, as was mentioned before, this species is to be considered synonymous with the widespread *P. moranensis*. Julián noticed another peculiar characteristic: the presence of non-glandular trichomes along the midrib of the lower (abaxial) surface of the leaf. This feature has not been reported for *P. moranensis*, and we believe that an in-depth genetic study is necessary to discriminate between both species and resolve their taxonomic status.

We continued our trip along the same Highway 15 (Huajuapán de León-San Miguel Tlacotepec) until our next stop, a population of *Pinguicula heterophylla*, known by collectors and enthusiasts of this group as Tonalá. In this place, we missed the fresh weather of El Boquerón, because the temperature was above 30°C, and the xerophilous scrub provided little shade. The landscape was dominated by shrubs of different species of Leguminosae and trees of the magnificent *Fouquieria ochoteranae*. The first spot we visited was a small canyon, in which we found a few plants of *P. heterophylla* on a small gypsum wall behind the shrubs (Fig. 7a). To our delight, some plants had flowers, the color of the plants was pale green, and they were about 7 cm tall. We moved to an open area of low hills covered by gypsum and with smooth, bright white slopes that hurt our eyes due



Figure 6: Mané Salinas observing *P. rectifolia* plants. Note that the water level was at least one meter below its highest level.



Figure 7: a) Plants of *P. heterophylla* growing in a small canyon were pale green in color and showed a transition between the winter rosette and the carnivorous summer leaves. b) The second location was an open area of low hills covered by gypsum where the plants were bigger and had more flowers and fruits.

to the intense reflection of sunlight (Fig. 7b and 8a). Here we observed a greater number of plants wholly exposed to the sun. They were either alone or associated with *Selaginella lepidophylla* and a few xerophytic ferns. The convenience of the date of our field trip permitted us to observe the transition between the winter rosette and the carnivorous summer leaves, as well as buds, flowers, and capsules. At the locality, there were both plants with a green hue and many plants with a beautiful intense red color (Fig. 8b-c).

Pinguicula heterophylla occurs naturally in at least three states of Mexico (Morelos, Guerrero, and Oaxaca). It usually grows in oak and pine-oak forests, with some populations in tropical deciduous forest. Its elevation ranges from 850 to 3060 m, and soils are derived from igneous and limestone rocks. The peculiar and exceptional thing about the Tonalá population is that it inhabits a semi-arid ecosystem with gypsum soils, a unique habitat for the species (Fig. 8a). Also, this area is the type locality of *P. pygmaea*, a recently described annual butterwort. We were aware that it would be challenging to encounter plants of this species this early in the rainy season; nevertheless, we were on the lookout to see if by chance, we found any individuals, but sadly, we were unlucky. Heading back to the pickup truck and under the sparse shade of a bush, Julián skillfully pressed some individuals of *P. heterophylla* for herbarium specimens.

Almost every time we visit populations of Mexican *Pinguicula*, we notice that some of them are endangered. At this locality, we observed the construction of maybe houses or warehouses 500 meters from the population. This habitat alteration represents a severe threat to these *Pinguicula*, as well as other species' viability.

The last stop of our field trip was at the only known population of *P. medusina*; some authors consider this species as a synonym of *P. heterophylla* (e.g., Lampard *et al.* 2016). This taxon inhabits a small gypsum hill, where we could quickly locate them in the first few meters of the northeast-facing slope (Fig. 9a). Although the site is next to “Laguna Encantada”, a recreational area with a lagoon, a basketball court, and BBQ areas, the actual area where this species grows does not seem to be so disturbed, except for small areas that were recently burned (Fig. 9d).

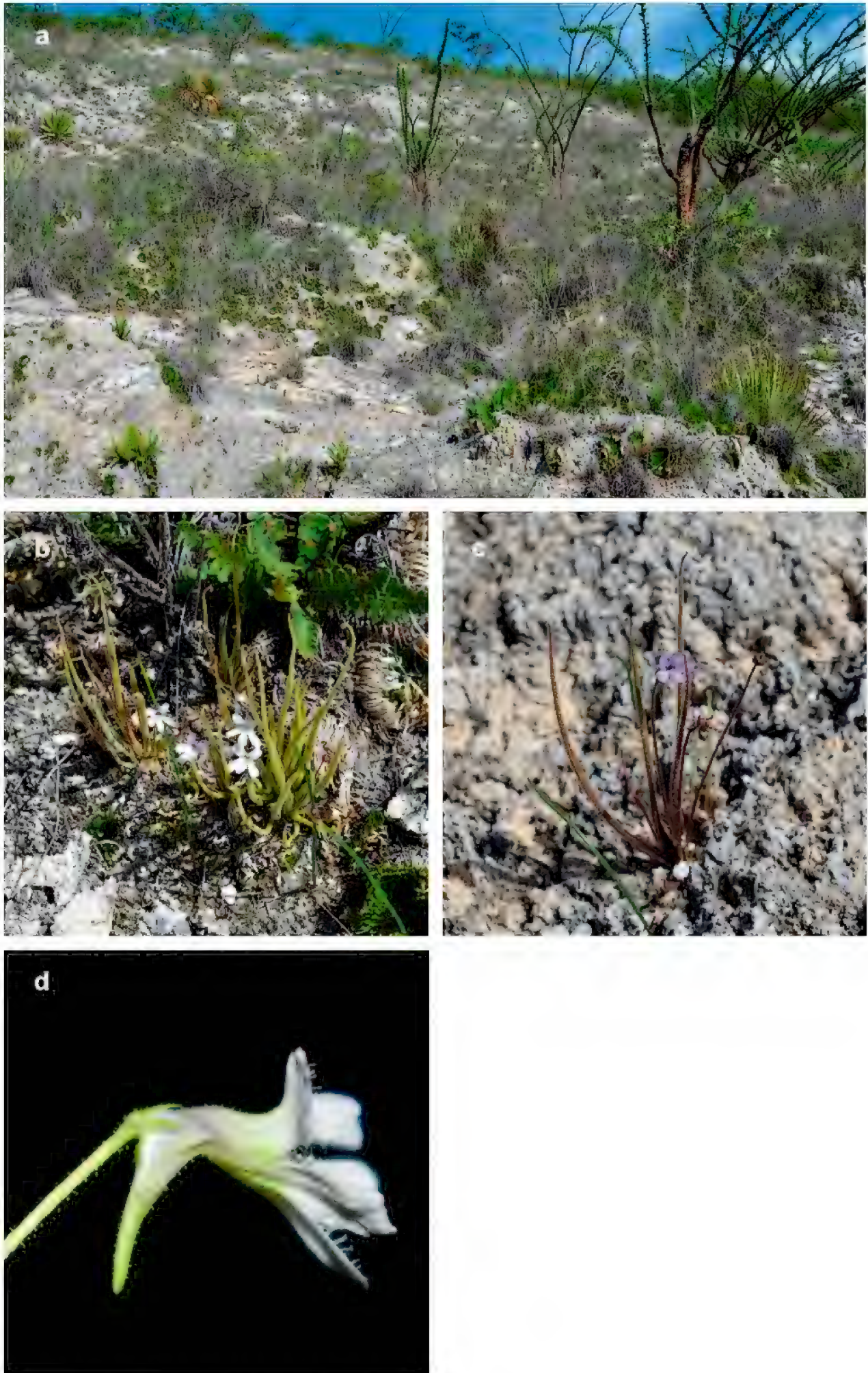


Figure 8: a) The singular habitat of *P. heterophylla* in Santo Domingo Tonalá, Oaxaca, low hills covered by gypsum. b, c) It is possible to observe plants with different pigmentation of leaves and flowers. d) Lateral view of *P. heterophylla* flower, where it is possible to observe that the spur forms an obtuse-straight angle in relation to the tube.



Figure 9: a) A gypsum northeast-facing slope, habitat of *P. medusina*. b) Lateral view of *P. medusina* flower. c) On the date of our field trip, it was possible to observe flowers and fruits. d) A small area of *P. medusina* habitat that was recently burned.

Pinguicula medusina is associated with *Selaginella* species and sometimes grows under the shade of the fan palm *Brahea dulcis*. Most of the plants of *P. medusina* were in the transition between winter rosette and summer leaves; many small individuals started to develop their summer leaves, but there were also adult individuals with flowers and developing fruits (Fig. 9c).

The particularity of this population lies in its unique asexual propagation that occurs at the apex of its leaves, where there are bulbils that later develop into new plants. This characteristic has not been reported in any other Mexican species of *Pinguicula*, except for the observations made by Oliver Gluch in a population of *P. heterophylla* in Oaxaca. At first sight, we noticed that *P. medusina* and *P. heterophylla* from Tonalá are quite similar, but we observed some differences, mainly in the flowers. According to the description of Zamudio & Studnicka (2000) and Zamudio (2006), *P. heterophylla* does not have a geniculate tube of the flower. However, we noticed that the Tonalá specimens have the tube of the flowers geniculate in the central part and that the spur forms an obtuse-straight angle in relation to the tube (Fig. 8d); in contrast, *P. medusina* has flowers with a non-geniculate tube, and the spur forms a sub-angle (Fig. 9b).

Thus, the question arises: could this population represent a variant of *P. heterophylla*? Again, we believe that is necessary to conduct more in-depth studies based on morphological and molecular criteria for the discrimination of these two species.

Finally, it occurred to us to end this field trip by looking for a population of *Pinguicula conzattii*; however, it was getting late and the approximate time to reach that population was 3 hours. So, we gave up and took the road back to Huajuapán de León, where we would spend the night. On the way back, the talk revolved around everything we had observed and what a delightful trip it was. While we were already traveling at night and in the darkness of the winding mountain roads, we took a curve and began to perceive a growing light. To our joy, we were rewarded with a spectacular and beautiful full moon that illuminated the remainder of the route. What better way to finish our field trip!

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CARNIVOROUS PLANTS OF THE WESTERN AUSTRALIAN GRANITE OUTCROPS

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At the end of winter in 2019 I embarked on an expedition to Western Australia to find carnivorous plants in the wild. This region is a center of diversity for carnivorous plants, with more than 100 endemic species. My journey took me on a long circuit around the countryside, starting with a drive through the forests of the South West towards the Great Southern coastline, then heading north east to the interior Wheatbelt region, before eventually looping back to Perth. Throughout my 17 days and roughly 3000 kilometers on the road, the geographical features that struck me most were the granite outcrops. These ancient landforms dominate the weathered landscape and give rise to unique habitats on which countless flora and fauna have evolved. It was in these granite ecosystems that I observed the most impressive displays of *Drosera* and *Utricularia*.

My journey began in a hurry as my plane landed late in Perth, and I was impatient to set off and begin the exploration of a lifetime! Hastily, I picked up the rental car, bought supplies for the next few days, and it wasn't long until I was on the highway driving at speed out of the city. In preparation for the trip, I had armed myself with a list of coordinates sourced from publicly available datasets, personal communications, and likely habitats that I had identified by scrutinizing Google Maps. This expedition was to be efficient, visiting a sure set of roadside locations as to leave enough time for some real exploration of the unknown. After a hurried half day of travel, I arrived in Bunbury and went to sleep early in preparation for a long day ahead.

The following morning, I woke up before sunrise to explore a nature park in the area, before setting off on the 250 km drive to the southern village of Walpole. After a few hours driving through agricultural pastures, I suddenly found myself surrounded by gigantic karri trees as I entered the forests of the South West. Here, high winter rainfalls and comparatively mild temperatures support the growth of dense forests, which are protected within the vast national parks the region is renowned for. It wasn't long before I arrived at my first site.

As I turned a corner, the canopy suddenly opened, and I was confronted with a gigantic granite outcrop smack on the road side. The grand monolith punctuated the dense forest surroundings, occupying the area of a sports field and rising some three stories high. Stained green with lichen and covered with a thick layer of moss, the rock seemed like a living entity, beckoning me to practically run out of the car to begin searching for carnivorous plants. Immediately at its base, I saw thousands of pink blooms dotting the swampy moss and realized that they were the flowers of *Utricularia multifida* (Fig. 1). I was worried that I would miss out on seeing this species of terrestrial bladderwort, which is known for its impressive en mass floral displays, but luck was on my side. As I traversed the outcrop, I spotted curious red tufts of sundews periodically sprouting up from the open moss. Upon closer inspection I found that these were *Drosera macrantha*, a scrambling species with long stems which, in the absence of a supporting perch, were windswept into tight balls. Climbing to the top of the outcrop, I began to appreciate the range of microniches that developed in different areas of the rock. The top of the monolith was plateaued out, and an accumulation of peat supported the growth of bushes. Intertwined within this scrub, I discovered *D. erythrogynae* and *D. aff. pallida* "South Coast" tangled in the growth. I was impressed with the proportions of these species, which reached well over 2 meters in length as they climbed the surrounding vegetation, using their sticky leaves to latch onto the branches. At the other end of the scale, the diminutive *Drosera modesta*, with its wiry lime green stems and small shield shaped leaves blended in well with the surrounding moss. I was simply amazed at the diversity a single outcrop could hold and with a sense of encouragement, I set off to find more!



Figure 1: *Utricularia multifida* growing on a large granite outcrop in the forests of the South West region.

After visiting a few more similar sites, I started to understand the ecological role of the granite outcrops and why carnivorous plants congregated around them. In general, carnivorous plants require three conditions to grow: water, a nutrient poor substrate, and sunlight. In the forests of the South West, the first two abiotic factors are provided by the high rainfall which has leached the soils of their minerals. The limiting factor here is sunlight, as the forest canopy and thick undergrowth blocks light from reaching the ground. The open surface of the granite outcrops provides a break in the dense bushland, giving access to the light and space that is needed by plants. These plants are incredibly adapted for harsh conditions – in the summer, as the weather warms and rains decrease, the thin covering of moss in which the species grow completely dries up. The tuberous *Drosera*, which constitute the largest group of species in Western Australia, survive the annual desiccation by retreating back into a dormant corm, whilst annual species like *Utricularia multifida* race to grow to maturity within a single season and set seed before they die. These fragile habitats are reliant on the annual cycle of winter rains and cool weather to rehydrate them. They are therefore extremely sensitive to the systematic effects of climate change and not immune to destruction by humans, despite being physically protected within the boundaries of national parks.

As I approached the coast, the environment transitioned from dense forest to coastal heath. While the low-lying profile of the ecosystem meant that access to sunlight is no longer an issue, the dense undergrowth nonetheless limits the amount of space where carnivorous plants can colonize. Again, the granite outcrops, which ranged from large monoliths to flat surfaces, served an ecological role by providing a blank sunny slate amongst the surrounding vegetation. Each site seemed to host a unique combination of species and it was exciting to see what I would discover at every stop. At most locations, I observed *Drosera erythrorhiza* colonizing depressions where moss and peat could accumulate (Fig. 2). This highly variable species forms a large rosette of flat circular leaves and the

plants in the region were mostly blushed with red. I also found a single population of *D. huegelii*, an erect species that grows a thin wiry stem adorned with dangling jellyfish-shaped leaves (Fig. 3). As the sun set, I finally arrived at Walpole exhausted and content with a very full day of discovery.

Over the next couple of days, I explored the coastal Great Southern region with interludes bashing around *Cephalotus* filled swamps and hiking in the endemic hotspot of the Stirling Range. Still, the occasional granite patch always provided reliable sightings of carnivorous plants. I was enamored one morning with *Drosera purpurascens*, a member of the *Stolonifera* complex that as its name suggests has stems of sprawling purple leaves (Fig. 4). The species in this section emerge towards the end of winter so, in contrast to the other tuberous species which were at the end of their growing season, *D. purpurascens* was at its physical prime. I found great beauty in the extremely dewy leaves sparkling like jewels amongst the shadows as they caught the low morning sun. Another interesting find was a granite-growing form of *D. microphylla*. This variety has large pink petals enclosed by red sepals and grew in mossy loam atop granite surfaces. This is in contrast to the heath growing form, which I observed to have small orange petals and golden sepals. Whilst the species has wide variation in color across its range (and color is not a valid taxonomic trait for distinguishing species), the combination of the separate niche occupation and color differences suggest at least some degree of genetic segregation. Perhaps in a few hundred thousand years they will diverge into something indisputably different and it was exciting to see evolution in process!

As my first week ended, I spotted *Utricularia menziesii* around the base of some large granite surfaces near Albany (Fig. 5). This species of terrestrial bladderwort is notable in both its appearance and adaptations to the Australian climate. Its large blood-red blooms have a long hanging protuberance that is somewhat reminiscent of the jacket tails of 18th century British soldiers, giving rise to its common name the “Redcoat”. Their habitat, wet moss at the base of granite and swampy



Figure 2: *Drosera erythrorhiza*.



Figure 3: *Drosera huegelii*.



Figure 4: *Drosera purpurascens*.



Figure 5: *Utricularia menziesii*.

water channels, dries up completely during summer. Unlike the annual *Utricularia*, this perennial species enters dormancy and forms a hibernating corm to survive the annual dehydration.

After a rewarding week of exploration in the Great Southern coast, my journey continued several hundred kilometers east towards the Fitzgerald River National Park before sweeping north to the agricultural Wheatbelt region near Hyden. The Wheatbelt is situated in the interior of Western Australia where winter rains and unending plains support the agriculture of wheat and canola. The land here has been extensively cleared for farming, replacing the indigenous semi-arid mallee shrubland and eucalypt woodland ecosystems. Paradoxically, this environmentally degraded region is also known for its intense biodiversity, which mainly congregates around the gigantic granite inselbergs that rise out of the surrounding plains as literal hills. These unfarmable monoliths and the small nature reserves that surround them provide crucial remnant patches of vegetation that protect an impressive diversity of flora and fauna, including many species of endemic *Drosera*. My plan for the next couple of days was to hop from outcrop to outcrop to see what I would discover.

It was soon to become evident that everything is bigger in the Wheatbelt. Coming to my first stop, I was immediately impressed by the grandeur of the outcrop and as it turns out, wholly unprepared for the sheer scale of the carnivorous plants that I was about to behold. As I approached the base of the rock, I noticed that the scrub was covered in strange patches of orange. Looking closer, I found *Drosera macrantha* and *D. subhirtella* growing to such densities that their matted stems formed a carpet that draped over the ground (Fig. 6). Giddy with excitement, I hurried forward to find vast colonies of *D. bulbosa* in the patches of moss on the rock surface and in the clay drainage field surrounding it (Fig. 7). The star shaped rosettes grew in abundance and littered the ground like confetti in shades ranging from bright yellow to dark purple. Confined to the moss was *D. lowriei*, a small species with a red mosaic of overlapping scale-like leaves. In the fields at the base of the outcrop, populations of *D. glanduligera* grew so densely that the ground gave off an orange sheen.



Figure 6: Masses of *Drosera subhirtella* and *D. macrantha* at the base of a granite outcrop in the Wheatbelt.



Figure 7: *Drosera bulbosa* surrounded by *D. glanduligera*.

Never in my life had I seen so many sundews in such vast quantities and I was left awestruck at this life changing sight.

My sense of amazement was renewed at each outcrop and I began to appreciate the complex niches that these rocks gave rise to. As light and space is plentiful in the open plains of the Wheatbelt, it seemed that water was the limiting factor for plant growth. The sporadic winter rains are quickly soaked up by the sandy fields and most watercourses in the region are saline from the accumulation of minerals over millennia. The granite outcrops serve a critical ecological role by providing impermeable surfaces that channel and accumulate fresh water around their base. This property has been recognized for thousands of years by First Nations peoples to provide permanent sources of fresh water and has been appropriated since colonial times with the building of dam walls encircling these rocks, redirecting the water towards reservoirs. However, it was not until an evening rainstorm that I truly appreciated the capacity of the rocks to collect water. As the heavens opened up, the channels in the rock quickly swelled from trickles to gushing streams as flood waters submerged the *Drosera lowriei* (Fig. 8) and *D. bulbosa* that grew in the moss. At the base of the rock, depressions in the ground quickly filled up with pools of water, transforming the area into an ephemeral swamp. Thousands of *D. rupicola* grew in this waterlogged soil, their lime-green leaves and white flowers contrasting against the dark wet moss (Fig. 9). It was amazing to see how dramatically the rain transformed the outcrops into such a dynamic habitat.

The following morning, I decided to check out some tourist sites which mainly consisted of various popularized granite features. Visiting some well-known locations, I saw a similar variety of species as the day prior with the addition of the erect species *Drosera yilgarnensis* and *D. stricticaulis*. These two species occupied shallow moss beds at the edge of bushy patches on the rocks. *Drosera yilgarnensis* is distinguished by a well-developed basal rosette, red foliage and a brightly colored sepal structure, whereas the light green *D. stricticaulis* grows perfectly orbicular leaves. Whilst the



Figure 8: *Drosera lowriei* temporarily submerged during a downpour.



Figure 9: *Drosera rupicola* growing at a popular tourist site. A dam wall can be seen towards the left.

beauty of the tourist sites was indisputable, I couldn't help but notice some conspicuous signs of human degradation. Weeds grew in abundance in the drainage fields around the outcrops, no doubt introduced by the shoes of the hundreds of daily visitors. On the rock surfaces, it was evident that the fragile moss gardens were trampled over, especially when they occurred near walking paths. Perhaps the most distressing example was the motorcycle tracks that brazenly scarred the delicate moss fields that covered the flatter outcrops.

I resolved to find a more undisturbed site to compare with and using Google Maps, I located a particularly remote granite outcrop protected well within the boundary of a large reserve. After a while of navigating through old paths and animal tracks, I was rewarded with one of the most beautiful sights I have ever seen. Around the entire base of the rock were dense fields of the eponymous *Drosera graniticola* (Fig. 10) growing in the thousands, their rust colored stems tinging the landscape with a metallic sheen as they swayed in the breeze. Against the low afternoon sun, the fields seemed to glow as the plants caught the light in their dew. This species grows impressive bouquets of flowers, with en mass displays that surely rival the non-carnivorous wildflowers that the Western Australian countryside is known for. While I had seen isolated patches of *D. graniticola* at previous locations, this undisturbed site was by far the most impressive stronghold for this "Priority Four" rare species, providing protection and allowing it to proliferate to impressive numbers. For me, it was one of the most apparent examples of successful conservation and truly reinforced the need to protect these wonderful locations from human destruction, both intentional and otherwise.

By now, I had been on the road for an exhausting 10 days. Eager to make the most of my final week, I continued back towards the west coast, allocating some time exploring the laterite hills of the north, before returning down south to Perth. My last few days were spent in the Darling Range, a hilly escarpment of granite that runs parallel to the coast and separates it from the Wheatbelt. This



Figure 10: *Drosera graniticola* growing en mass around a remote granite outcrop.

elevated geographical feature forces the humid coastal air to rise and precipitate rain, a process known as orographic lift, that contributes to locally high rainfall in the region. Like the South West, the wetness supports extensive forests of gigantic trees and the granite outcrops once again provided a break amongst the growth. Driving back to Perth, I found a beautiful site in an area earmarked for urbanization in the ridges of the Avon Valley. On a flat rock face that was covered with wet moss, I saw a field sparking from hundreds of *Drosera heterophylla* (Fig. 11). This water loving species is unique within the genus for producing flowers with many more petals than the usual five and is known for its especially lustrous dew.

As my time in Western Australia drew to an end, I decided to cap off my trip with a long mountainous hike deep in the Perth Hills. Despite all the amazing sites I had seen every day for more than 2 weeks, I was once again awed by the *Drosera* that grew in great abundance on the granite outcrops. I found *Drosera bulbosa* and *D. rosulata*, which in this area sometimes look very similar to each other in that they both can have rounded deep-red leaves. The latter species can be distinguished by a sunken central vein and slight preference of loam over moss. Once again, *D. pallida* and *D. macrantha* occupied the shrubs on and around the rocks in impressive numbers (Fig. 12). The scrambling stems reminded me of flames as they emerged from the bushes in lustrous shades of copper and gold, their dew illuminated against the sunlight. A new discovery was made in the sighting of *D. menziesii*. This vibrant red erect species grew in the thousands in the mossy drainage fields of low-profile rock surfaces in the area.

But the species I wanted to see the most was the iconic *Drosera gigantea*, which has always captured my imagination with its branching tree-like morphology. This species is probably the last of the tuberous sundews to emerge, breaking dormancy at the end of winter and growing well into the summer. Its early growth phase, which has an uncanny resemblance to asparagus stems, could be seen everywhere poking out of the wettest soils but I was yet to find mature specimens in any



Figure 11: *Drosera heterophylla*.



Figure 12: *Drosera pallida* and *D. macrantha* in the Perth Hills.



Figure 13: A field of the red and green forms of *Drosera gigantea*.

impressive quantity. My prayers were finally answered as I reached the last site of my last day. Amongst a recently burned patch of forest, I spotted the familiar glow of sundews in the swampy field of a small outcrop. Both the green and red form of *D. gigantea* grew alongside each other in great numbers, all plants displaying a full set of foliage (Fig. 13). It appeared that the recent fires and sub-flowering age of the plants had stimulated them to grow leaves relatively early at this particular site. Against the golden light of the late afternoon sun, the area came alive with patches of sparkling leaves, their vibrant aura contrasting dramatically against the shadows. For the first time in my hectic journey, I just paused and took in the beauty around me and as the sun set over the field of *Drosera* I knew that I was fully satisfied with my expedition.



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GROWING *GENLISEA*

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Introduction

The *Genlisea* genus belongs to the *Lentibulariaceae* family and includes thirty carnivorous species originating in the tropical regions of Africa and Central and South America where they share the habitat with *Drosera*, *Utricularia*, *Heliamphora*, and *Brocchinia*. They occupy wet meadows that are poor in nutrients or sandy areas on the Venezuelan tepuis.

The *Genlisea* species do not have a real root system, but the carnivorous traps are modified underground leaves that anchor the plant to the ground and absorb liquids and nutrients. The trap-leaves have lost pigmentation and also the ability to photosynthesize. Carnivory was demonstrated only in 1998, although the genus has been recognized since the beginning of the 1800s.

The above-ground basal leaves are arranged in a rosette and are of two types: spatulate or linear (Fig. 1), ranging in size from a few millimeters (*G. pygmaea*) to 12 centimeters (*G. guianensis*).

The trap

The leaf trap is certainly what distinguishes *Genlisea* and fascinates the growers. Starting from the surface of the soil, and roughly from the center of the rosette, a terete footstalk and then a hollow tube containing the vesicle develops downwards; the vesicle is a bulge, where the real digestion of the prey that have travelled up inside the trap itself takes place (Fig. 2; Front Cover). At the end



Figure 1: Spatulate leaves of *Genlisea subglabra* (left) and linear leaves of *Genlisea roraimensis* (right).



Figure 2: *Genlisea* traps.

of this hollow tube, the leaf-trap divides into two twisted (flat) helical arms. The edges of this “ribbon” have dozens of holes through which prey can enter the trap. The inside of the trap is rich in small hairs turned inward, that is towards the vesicle, allowing the prey to only move toward the vesicle. Sometimes prey dies along the trap, before getting to the vesicle, and the plant assimilates the nutrients coming from the decomposition of those prey.

But why do prey enter the trap of *Genlisea*? At the moment there are no known mechanisms for attracting prey, and there are currently no known chemical attractants. The prey enters the traps perhaps without apparent reason or perhaps assuming a sort of dark “cave” that provides protection. The most common prey that have been found inside the traps are protozoa, small invertebrates, nematodes, and algae (Fleischmann 2012).

Cultivation

At the time of writing, I’m growing *G. africana*, *G. aurea*, *G. exhibitionista*, *G. flexuosa*, *G. glandulosissima*, *G. hispidula*, *G. lobata*, *G. margaretae*, *G. nigrocaulis*, *G. oxycetron*, *G.*



Figure 3: *Genlisea* growing in a terrarium.

pygmaea, *G. repens*, *G. roraimensis*, *G. subglabra*, and *G. violacea* and my experience is about these species.

According to my experience, *Genlisea* cultivation is simple and, although the different species grow in places of the Earth that are distant from each other, I have managed to cultivate, reproduce, and make all these species bloom by cultivating them under the same conditions.

I keep my plants in terrariums (Fig. 3). The minimum temperature does not drop below 15-18°C at night, the water level is very high, it reaches the top edge of the pot. I add water from time to time, after letting the water level drop one or two centimeters.

My pots rest directly on the bottom of the terrariums where in the stagnant water, algae and deposits form. I rarely clean the terrarium; the micro fauna that forms on the bottom of the terrarium could feed my *Genlisea*.

The insolation in the places of origin, for the species I grow, is strong, so I keep the plants under T5 fluorescent tubes with different color gradation, the number of which depends on the size of the terrarium.

The pots must be at least 10-12 cm tall. Although the aerial part of the plant is small, the underground traps develop in unexpected lengths (Fig. 4). I tried different substrates without apparent changes in the development of different species, so today I use a mix composed of 70-80% quartz sand and the rest of peat.

Over the years, I have thought that live sphagnum could help maintain a healthy and moist environment. The idea is not wrong, but the sphagnum in the terrarium grows faster than any *Genlisea* species and I therefore abandoned the idea.

Flowers and Pollination

It is not easy to distinguish *Genlisea* plants from *Utricularia* plants if the traps cannot be observed, but the flowers of the two genera can easily help. The flowers of *Utricularia* have only two sepals, while *Genlisea* have five (Fig. 5).

Artificial pollination occurs exactly as for *Utricularia* or *Pinguicula* (remember that the three genera belong to the same botanical family). The small size of the flowers is certainly not an advantage! Equipped with an excellent view and a small tool to recover pollen (I use dry flower stems), the flower is held between the forefinger and thumb of my hand. The flower must be opened along its horizontal axis to expose inside of the flower. With a thin tool, the pollen is recovered from the stamens of the flower and dragged onto the pistils, which looks like a small lamella (opening) near the mouth of the flower. Small hands, a lot of delicacy, and a lens can be of great help! But with the



Figure 4: *Genlisea* growing in a deep pot.



Figure 5: Flowers of the man-made hybrid *Genlisea lobata* x *flexuosa* (left). *Genlisea* flowers have 5 sepals (right).

flower in one hand and the small tool in the other, the magnifying glass must be held by a collaborator or you need a tripod.

Multiplication

For my experience *G. africana*, *G. aurea*, *G. exhibitionista*, *G. flexuosa*, *G. hispidula*, *G. lobata*, *G. margaretae*, *G. pygmaea*, *G. roraimensis*, *G. subglabra*, and *G. violacea* reproduces quite well by leaf or trap cuttings, I use the same substrate as the plants in cultivation. The leaf must be entirely resting on the surface of the media. In two or three weeks, the first traps emerge from the lower side of the leaf and enter the ground (Fig. 6). Later, several rosettes are formed which will give rise to more plants.

I use the same technique for the trap cutting, which turns out to be a good method because the traps are very delicate and break easily when handling plants.

Every now and then traps develop on the flower stem of my *G. hispidula* (Fig. 6). New plants will grow if the stem with plantlets is placed on the surface of the soil.

Reproduction by seed can be difficult. I have had rare successes and only with the seeds from my plants since the seeds must be very fresh in order to have the possibility of germinating. The



Figure 6: Rooted leaf cutting (left); plantlets forming on the flower stem (right).

small seeds are scattered on the surface of the pot without covering and the water level must exceed the height of the soil, taking care not to float the seeds, until the first shoots are seen, then the water level is lowered.

Curiosity

Genlisea aurea is completely covered with a mucilaginous substance. I spent a lot of time cleaning the plant believing that they were harmful algae, but *Genlisea aurea* continued to become covered with this substance until, years later, I read about this characteristic and I no longer pursue it!

Reference

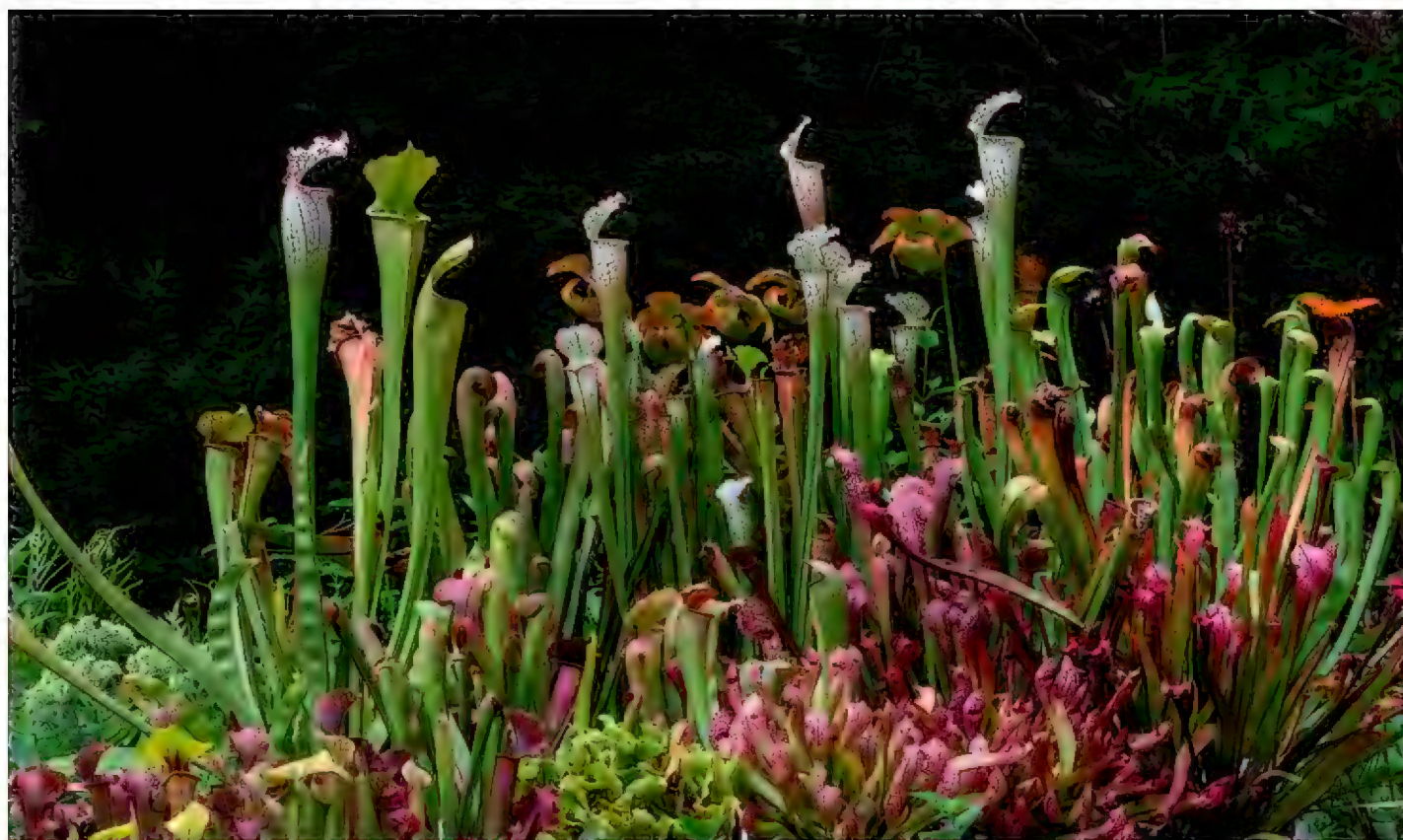
Fleischmann, A. 2012. Monograph of the Genus *Genlisea*. Redfern Natural History Productions Ltd., Poole, UK.

BUTTERFLIES LOVE *SARRACENIA*

ROBERT BARR • Carrollton • Georgia • USA • rbarr@mindspring.com

My interest in “meat eating” plants began in the mid-1950’s when as a typical six-year-old I snatched my older brother’s DC Comics to read about Superman, Batman, and all the lesser gods within that pantheon. Of no less fascination to my eager eyes were the back pages of those monthly chronicles where mail order items resided that were every bit as fantastic to a youngster’s vivid imagination as the feats of super-human derring-do performed by the heroic champions. For mere pennies, ... okay, for a few bucks, one could order x-ray glasses or ventriloquism lessons or sea monkeys (later revealed to be brine shrimp that didn’t look a thing like monkeys) or, best of all, huge man-eating, meat-eating plants with the other worldly name of Venus Fly Traps! Over the next few years I ordered and killed several of those less-than-threatening little plants that had been ripped from their native environments in North Carolina and fed into the meat grinder that was mail-order sales in that day and age.

Fast forward several decades to find me retired and with the free time to revisit some of those interests we all have filed away in the folder “When I have enough time, I’m going to...”. At the beginning of the second decade of this still-new millennium I began to devote an adult’s level of interest to the carnivorous plants native to my home state of Georgia and the region. I began by attending a full day workshop just north of Atlanta at the Chattahoochee Nature Center conducted by Henning von Schmeling on pitcher plants of the Southeastern United States. I couldn’t have received a higher voltage jump start for my engine than he provided. Returning home with a self-made container bog



This photo was put together for use in presentations to garden clubs, civic groups, Master Gardener chapters, etc., entitled “A Child’s Garden of Carnivorous Pitcher Plants” to illustrate the beauty and diversity of the genus *Sarracenia*. I failed to notice during the photography session that a Gulf Fritillary butterfly (*Agraulis vanillae*) had photo-bombed me at the upper right of the image. Butterflies truly love *Sarracenia*!

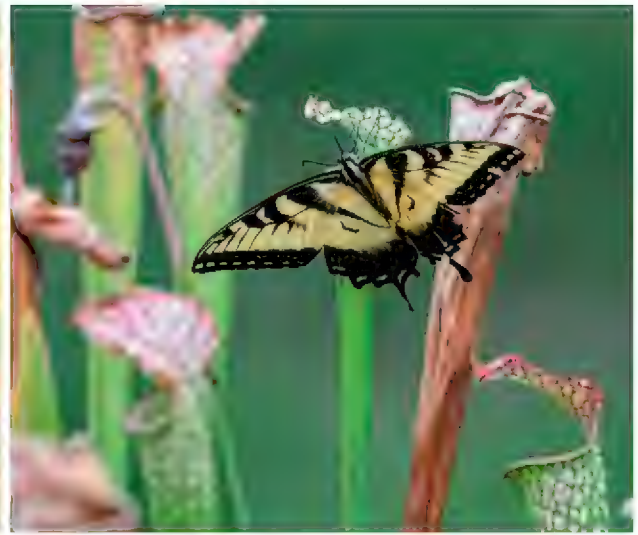
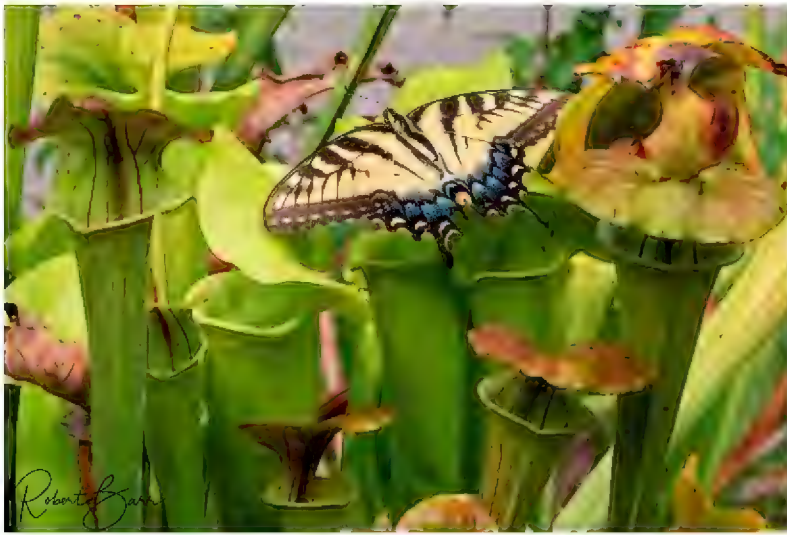


Common along the margins of woods throughout Georgia, Red-Spotted Purples (*Limenitis arthemis astyanax*) spend time each Spring and Summer. Some of that quality time is spent perched atop *S. leucophylla* sampling the sugary lures exuded by the pitchers to lead smaller prey to their doom. Their striking colors have evolved to mimic the toxic Pipevine Swallowtail butterfly. The *S. leucophylla* seen here was grown from seed harvested a few hundred kilometers to the southwest in Baldwin County, Alabama, and purchased by the author from the ICPS Seed Bank five years ago.

replete with four species of *Sarracenia* and a gnawing hunger to make up for so much lost time, I ordered books on carnivorous plants, I visited websites, I viewed streaming videos, I emailed collectors and vendors, I visited bogs in Alabama, Georgia, and north Florida, I joined ICPS, I did all the things that many of you who are reading this article have quite likely done.

I now have more cp's (I picked up some jargon along the way as well), primarily of the genus *Sarracenia*, than I have room to accommodate; nevertheless, I continue to acquire more. Every addict continues to crave a stronger and stronger fix, more and more of the stuff that dreams are made of, greater doses of the magic elixir. It is an addiction with the acronym CPAS (Carnivorous Plant Acquisition Syndrome). I am one happy cp junkie.

But enough about me. I want to offer an interesting tidbit to a readership composed almost entirely of more erudite, formally educated, well informed, and more experienced individuals than I on the subject matter at hand: an observation I have made in the past decade regarding an ongoing relationship between members of the genus *Sarracenia* and the order *Lepidoptera*. My home lies in the Georgia Piedmont geologic region of the USA, an easy hour's drive west from Atlanta toward Alabama. The location, while devoid of *Sarracenia* (that I know of), allows me to enjoy the abundance of sites west into Alabama, Mississippi, and Louisiana, and northeast into the Carolinas, and south throughout the Georgia coastal plain (and the Okefenokee Swamp!), and into the Florida Panhandle. As I became familiar with the ideal situation of my habitation, I felt



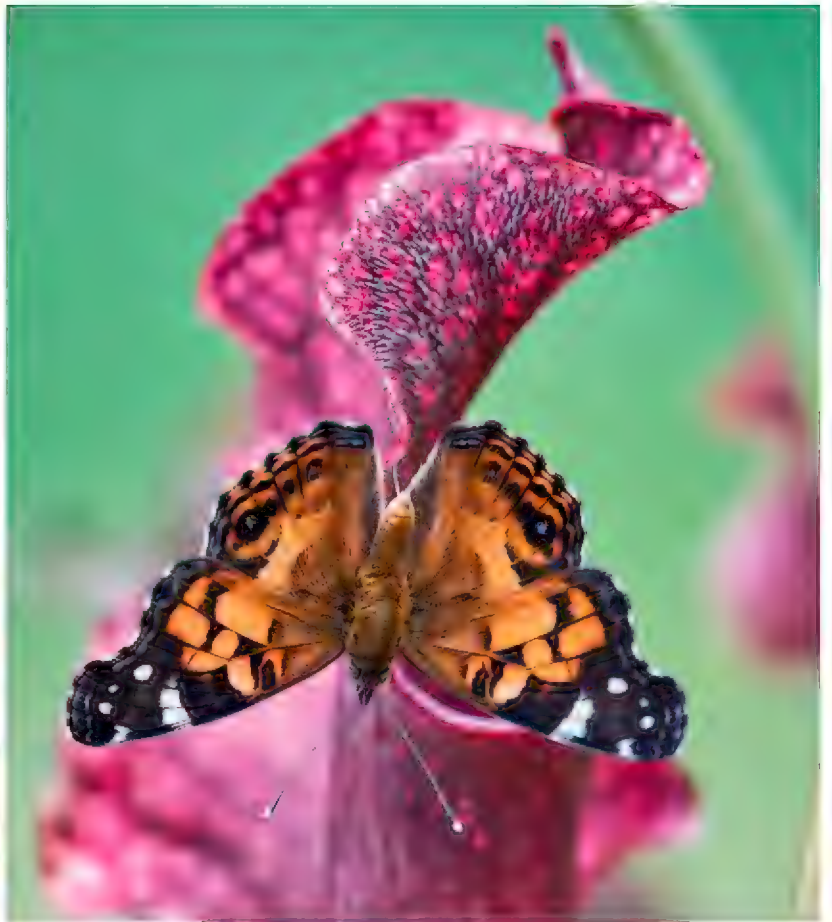
Eastern Tiger Swallowtails (*Papilio glaucus*) are among the largest, most striking, and most often seen butterflies in the Georgia Piedmont region. Accordingly, they are one of the most frequently observed species visiting pitchers in the author's bog gardens to sample the nectar lures on a variety of *Sarracenia* species. None of the species observed visiting pitchers seemed to evince a preference for one *Sarracenia* species over another; however, none have been observed on any of the decumbent species of *Sarracenia*.

not unlike the proverbial blind dog in the butcher shop! So many wonderful things to sample! What to do first?

But back to my interesting observation. In the decade that I have been afflicted with CPAS, I have noticed an occurrence that, while I make no claim to its being unique to my location or that I am the first to take note of it, I have not come across any other accounts of it in this periodical or



Cloudless Sulphur butterflies (*Phoebis sennae*) can be seen throughout the warm months, but their numbers swell through August into September as they migrate southward for the winter. These individuals have found the nectar line along the ridge of a *S. minor* 'Okee Giant' obtained from a California grower. It has reached a height of 50 cm growing outdoors here in USDA Hardiness Zone 7b. Winter patterns in this locale tend to be erratic with several mild winters having lows no colder than about -4°C followed by a severe winter with minus double digit lows and a string of days when the thermometer fails to climb above the freezing mark. Within any given winter, weeks of intermittent freezing temperatures at night can be followed by a "February thaw" with balmy days above 15°C or even above 20°C only to be followed by another string of below freezing days and nights.



A Gulf Fritillary (*Agraulis vanillae*) sits atop *Sarracenia minor* (left); *Sarracenia* ‘Judith Hindle’ is an ideal plant to select for beginning hobbyists. Intense color and ease of cultivation make them a favorite for most collectors. Here an American Painted Lady (*Vanessa viginensis*) enjoys sweetness from the lip of Judith (right).

any of the books I have read. I have coined the term “Unintended Friends with Benefits who Offer Little or Nothing of Benefit in Return but at least do no Damage and look really Pretty in the Process” to describe the activity. Almost every species of butterfly commonly found in my part of the world feeds regularly on the “nectar” bait secreted by the *Sarracenia* in my bog gardens. As I speak



The wings of an American Painted Lady conform perfectly with the arc formed by the lid of *S.* ‘Judith Hindle’ (left). The sturdy 60 cm pitchers of this *Sarracenia flava* × *leucophylla* hybrid provide a platform on which a Common Buckeye (*Junonia coenia*) rests (right).



A Silver-spotted Skipper (*Epargyreus clarus*) samples the sweetness on the lid of *Sarracenia flava* (top left), while another skipper feeds along the top of *Sarracenia* x *excellens* (top right). Although small enough to easily fall prey to the pitchers, the author has never witnessed any of these small butterflies fall victim to *Sarracenia* in his garden. The only butterfly to have ever been seen to become prey was an American Painted Lady that slipped into the pitcher of a large *Sarracenia leucophylla* (left).

to garden clubs, Master Gardener groups, Georgia Native Plant Chapters, school groups, and total strangers who I am able to corner in stores or on sidewalks about the pleasure to be derived from adding winter hardy *Sarracenia* to their home garden roster, I stress the *Sarracenia*'s ability to attract the beauty of butterflies into their realms. While we all know that *Sarracenia* are carnivorous, and butterflies would certainly be on their menu, the butterfly's large wingspan precludes all but the smallest from becoming dinner while they are enjoying their nectar dessert.

I hope the readership of our own ICPS Newsletter might enjoy a view of some of the pairings that I have recorded.

NEW CULTIVARS

Keywords: cultivar, *Sarracenia* ‘Sarramphor’, *Sarracenia* ‘Wizzleberry Toad’.

Sarracenia ‘Sarramphor’

Submitted: 9 November 2019

Sarracenia ‘Sarramphor’ is a hybrid from seeds I received in 2008 from Brooks Garcia, Atlanta, Georgia, USA, with the label “*Sarracenia wilkerson red* X ???”. A personal comment by Brooks on Facebook was: “Hard to conjecture as to what the “?” may have been but, looks as if it could have been *S. rubra alabamensis*.”

Sarracenia ‘Sarramphor’ has a beautiful red flower. There is fine red venation inside and outside the pitchers (Fig. 1). The tallest pitcher for me has been 25 cm so far, but I do not fertilize my plants.

The cultivar name Sarramphor honors the beautiful shape especially the strikingly “heliamphoroid” plunging neckline of the peristome and the small lid both of which resemble a *Heliamphora* plant.

To maintain and preserve the unique features of this cultivar it will be best if propagation takes place only by division of the rhizome.

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Figure 1: *Sarracenia* ‘Sarramphor’ pitchers and flower. Left photo by Guillaume Bily, right by Alexander Fisch.

Sarracenia 'Wizzleberry Toad'

Submitted: 27 October 2019

Sarracenia 'Wizzleberry Toad' is a hybrid of *Sarracenia moorei* #2 (Sunbell Exotics) × *S. purpurea* f. *heterophylla* Nova Scotia (Meadowview). I made this cross in the spring 2014 and germinated the seed November 2014.

It is super vigorous and divides quickly which I noticed while still growing with its siblings indoors through the 2015 season. In 2016, in its first season outside, its vigor proved to be a stable trait, making 7 growth points before the end of its second season. The pitcher is 25 to 33 cm tall. The peristome forms a more square than round shape with a double fold at the front of the lip (Fig. 2). The opening is 4 to 5 cm across on mature pitchers. The lid is upright and well ruffled, folding together at the center top to create a wizard cap appearance.

The color is incredible. Pitchers start green as the lid opens and the red coloring begins in the interior throat. Then becoming more pronounced, spreading up the lid and down the tube. The upper pitcher and lid continue coloring, first into a bright raspberry, later deepening to a dark raspberry to almost purple. The entire upper pitcher eventually becomes fully colored, leaving just a hint of the yellow green windows around the outermost margins of the lid and also, on close inspection, visible on the tube as well. The rhizome and lowest 8 cm of the leaf stem remains green, the front blade is also green a little higher on the tube. The flowers start green then open to reveal beautiful orange to raspberry colored petals.

Sarracenia 'Wizzleberry Toad' makes long lasting pitchers all season. At the end of the season, pitchers become somewhat smaller indicating dormancy is starting. The best of season pitchers are from the late May until mid-October.

I chose the name Wizzleberry Toad in August 2016. It was a simple choice because of the wizard-like cap, raspberry color, and compact size.

Sarracenia 'Wizzleberry Toad' must be propagated by vegetative division to maintain this unique beauty.

—JIMMY CONNER • Roanoke • Virginia • USA • uphwiz@yahoo.com



Figure 2: *Sarracenia* 'Wizzleberry Toad' early and late summer (left to right).

BOOK REVIEW

Mann, H., and Burzynski, M. 2018. *Flesh-Eating Plants of Newfoundland & Labrador and the Maritime Provinces*. Softcover, 193 + X pp., ISBN: 978-0-9699509-9-8.

Gros Morne Co-operating Association. \$29.95 + shipping, from grosbornecoop.com (email: darlene@gmist.ca).

Reviewed by Barry Rice

Why buy books? Really? There is so much information available on-line, for free, is there really a point? This book reminds me that there is.

My first encounter with this work was a year or so prior to its publication. One of the authors contacted me with a request for a few images. If I recall, they wanted to use a few of my *Utricularia* images. I provided them free of charge, as I do for authors working on carnivorous plant books, but I was intrigued. People frequently ask for images of *Sarracenia* or *Drosera*...but someone wanted images of obscure *Utricularia*? I was intrigued. I offered to look over their text, and relay any useful comments I thought I might provide.

When I opened the files to see how they treated *Utricularia*, I was agog. Simply.... amazed. These authors treated *Utricularia* properly. In fact, in a way, I have never seen a better treatment of these plants!

OK, I have gotten ahead of myself.

This book treats the carnivorous plants of northeastern Canada—*Sarracenia purpurea*, *Pinguicula villosa*, and *P. vulgaris*, five *Drosera* (and hybrids), and eleven *Utricularia*. It includes nice, concise treatments of related issues such as conservation, carnivorous plants in popular culture, *Dionaea*, the use of hand lenses, and other nifty little topics.

But the species treatments are the soul of this book, and they are really extraordinary.

I am simply enraptured by how much geeky, lovely information is provided about each plant. For example—in the *Drosera* treatment there is a key (oh thank god, someone still remembers how to write a key!!!). There is a nice one-page comparison of leaf shapes. For each species there is a range map (yay!) and photos of the plant in full growth, details of the leaf shape, photos of the flowers, seeds, fruit, hibernacula, and on and on. It's great.

Let me give you another example of their detail. Consider the treatment for *Utricularia geminiscapa*. (Not the most famous plant, right?) This species is given six pages, including seventeen color images which show the vegetative shoots, the aerial flowers, the aquatic flowers and fruit, bladder images, leaflet margins, and...yes...quadrifid gland images.

Structurally, the book is superb. The images are top quality, the text is clear, the typography and overall layout is excellent. There's really nothing of significance wrong with this book; meanwhile, there's everything right with it.

Simply noted, buy this wonderful book.

Disclaimer: A blurb I wrote appears on the back cover, and some of my images appear in this book, but I have no financial connection with this book's publication.

